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| **Environments** | **Investigation 3:** | **Water Tolerance** |

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| **How does this investigation fits within the Concept and Lesson Map:** |
| To run a controlled experiment with plants in order to learn more about the environmental factors, moisture, impacting the terrarium ecosystem. The idea of an optimum soil moisture condition within a plant’s range of tolerance is introduced and is the main focus of this investigation. |

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| **Overarching Question(s) for the Whole Investigation** |
| * How do plants respond to changes in environmental factors? * How specific are the needs of plants? * “For any particular environment, some kinds of plants and animals thrive, some do not live as well, and some do not survive at all.” (Atlas, p. 33) * How do the key understandings connect to real world agricultural problems? |

**How People Learn #1: Preconceptions**

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| **Eliciting Student Ideas:** |
| * Formative assessment: Response Sheet for Investigation 3 (WA Edition, Modified Student Sheet No. 11) * After all data has been collected, students may share conclusions with their classmates by drawing their own “tolerance gauge” on whiteboards and explaining how their evidence supports the gauge. (NCOSP Supplementary material, July, 2009) * Strategies that the teacher could use to help students recognize the strengths and weaknesses of their data collection procedures (student sheet #10):   + Create a class line plot to the shape of the data and outliers.   + Ask students how they measured each growth structure (technique as well as units).   + Explain why these growth structures might provide evidence for a range of tolerance and an optimum condition. |

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| **Common Student Preconceptions:** |
| * “Most children recognized plants’ need for soil, water and sunlight in their habitat. Consumers were thought to need water, food and shelter”(*Making Sense of Secondary Science* page 63) * “…they often think of organisms as independent of each other but dependent on people to supply them with food and shelter”(*Benchmarks for Science Literacy* page 342) * “…younger children (up to 13) seemed to think in terms of the needs of individual organisms rather than of populations”*(Making Sense of Secondary Science* page 63) * Students might also assume that different plants need the same amounts of water. |

**How People Learn #2: Facts/Concepts/Knowledge**

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| **WA State Content Standards “Science Domains” (EALR 4)** | |
| 4-5 LS1C | Certain structures and behaviors enable plants and animals to respond to changes in their *environment*. |
| 4-5 LS1D | Plants and animals have structures and behaviors that respond to internal needs. |
| 4-5 LS2D | *Ecosystems* can change slowly or rapidly. Big changes over a short period of time can have a major impact on the *ecosystem* and the *populations* of plants and animals living there. |
| **WA State Science Standards “Crosscutting Concepts and Abilities” (EALRs 1-3)** | |
| 4-5 INQD | *Investigation*s involve systematic collection and recording of relevant *observations* and data. |
| 4-5 SYSC | Systems have *inputs* and *outputs*. Changes in *inputs* may change the *outputs* of a *system*. |

**Continued on** **back**

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| **Key Understandings for the Teacher:** |
| * The soil moisture needs of plants become more specific as the seeds move through the stages of growth from germination to adult. * The range of tolerance for the environmental factor of soil moisture varies for different plants. * Students may require more scaffolding for experimental design if they have not had previous experience through FOSS or other lessons. * “ The conditions that are most favourable to an organism’s survival, growth, and reproduction are optimum conditions.” (FOSS: Environments: Water Tolerance, p.4) * The only environmental factor tested in this investigation is soil moisture, but the class conversation should be directed toward the idea of range of tolerance for environmental factors as a whole. * This investigation provides a great opportunity to return to their terrariums from Investigation 1. They should be able to apply understandings from this investigation to environmental factors within their terrarium ecosystem. |

**How People Learn #3: Metacognition**

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| **Metacognition: How did my thinking change? What caused the change? How did I come to believe this?** |
| Part 1: In Step 12, have students compare their results with their original prediction. |

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| **Evidence of Student Understanding:** |
| * At end of Part 2: Response Sheet (WA Edition Modified Student Sheet No. 11) use provided rubric * At end of Part 3: Notebook Prompt (WA Edition Assessment p. 28) Teacher modeling for writing a conclusion might be necessary. * Observations Rubric (FOSS Assessment Folio, p.11) use during Part 3 * At end of Part 3: Part 3: Notebook prompts with rubric (WA Edition, Modified Student Sheet No. 11) * At end of Part 3: Students should apply their new learning to their observations (written in science notebooks or expressed during conversations) of their terrariums from Investigation 1. |

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**Additional Information**

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| **Materials and Student Management** |
| * Start using the “tolerance gauge” (NCOSP Supplementary material, July, 2009) * Prior to Investigation soil needs to be dried. * Plants might grow better with use of a grow light. It’s important that all plants receive the same light treatment. Currently, each school has one grow light with stand. * In Part 3, slow down and organize the uprooting procedures so it is easy for groups to determine which sprouts are from each moisture condition. One student at a time can dismantle one planter and distribute the plants to the student(s) responsible for each type of plant profile. For example, the student with the “dry condition” planter uproots all the plants and carefully distributes the pea plants to the student with the “pea plant profile” so he/she can tape those “dry condition pea plants” onto the pea profile in the right place (and then continues this process with the barley, corn, and radish until this planter’s sprouts are sorted out correctly and taped in the right places on the plant profiles). * In Part 3, plant profiles wilt quickly. Take digital photos to save evidence for discussions. |

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| **Timing Considerations** |
| Because growth time for the plants is necessary, this Investigation will be running concurrently with Investigation 1 and 4, as students may be continuing to collect data from the Investigation 1 terrariums and you may be beginning Investigation 4. |

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| **Helpful Resources and Bibliography:** |
| * Washington Edition: Assessment Environments, Grade 5 Version (Updated formative assessment packet, 2006) * Benchmarks for Science Literacy (AAAS, 1993) * Making Sense of Secondary Science (Driver, et. al 2006) * Science Curriculum Topic Study: Ecosystems, pg. 127 (Keeley, 2005) * Atlas of Science Literacy, V2. , p. 33 (American Association for Advancement of Science, 2007) |